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MAN AND HIS NERVOUS SYSTEM IN THE WAR

BEING SOME REFLECTIONS UPON THE RELATION OF AN ORGANISM TO ITS ENVIRONMENT. II

By Professor F. H. PIKE

THE DEPARTMENT OF PHYSIOLOGY OF COLUMBIA UNIVERSITY

MAN IN HIS RELATION TO HIS ENVIRONMENT. MAN'S REACTION TO SOCIAL AND POLITICAL CONVENTIONS

THESE considerations must be urged as a justification for the attempt of a physiologist, representative, loyal though confessedly unorthodox in many particulars, of a science that has concerned itself far more with internal organization than with the effects of, or reaction to conditions in the environment, to go back along the road of the naturalist which he traveled as a student, to set forth in brief the general features of man's reaction to war and war conditions from the point of view of the organization of the nervous system. For it is through the nervous system that the reactions which I wish to describe have arisen. In order to do this, we may first look a little more closely at the manner of organization of the nervous system and some of the changes it has undergone in the course of organic evolution.

The possibility of affecting the organism through its nervous system has been mentioned. The property of irritability or excitability is highly developed in nervous tissue. And its sensitiveness, as was previously stated, is further increased by the development of highly specialized sense organs at the periphery. The eye and ear are familiar examples of such sense organs. A sense organ has been defined as a mechanism for decreasing the threshold of a stimulus, *i. e.*, a mechanism for making the organism more sensitive to a given form of energy in the environment than it would otherwise be. A very intense light or an extremely loud sound would be necessary to stimulate a nerve trunk directly, but through the mechanism of the eye or the ear, almost any measurable intensity of light or a very slight sound may set up a nerve impulse which, on reaching the central system, is interpreted as sight or hearing. The nervous system, through its peripheral sense organs, is more sensitive to some agents in the environment than the chemical mechanisms of the body. And the greater the number of sense organs or the higher their degree of development, the more sensitive does the organism become. Some animals have more highly developed sense organs of a particular kind than man, as for example, dogs, which have a more acute sense of smell. Other forms probably have sense organs for the perception of certain agents in the environment which man is unable to appreciate without the aid of laboratory instruments. But the fact remains that man is sensitive to many manifestations of energy in the external world.

Mere sensitiveness to agents in the external environment constitutes but one side of the picture. The reaction of the organism to the agent in the environment is still to follow. And given the same set of external conditions, animals of different species may react in different ways, or different individuals of the same species may exhibit considerable variation.[1] In general the lower forms of vertebrates exhibit the greatest degree of uniformity of reaction. And often the first time a young animal reacts, its response is similar in every way to that of an adult animal which has given this particular response many times. Whitman calls such responses instinctive responses and we may refer to his graphic description of the action of a young puppy when it first takes food as an illustration. He attributes their peculiar manner of execution to the (internal) organization of the animal; and going a step farther, we may recall Magendie's statement that instinctive responses are dependent upon the organization of the nervous system. A little further up in the animal scale, the element of a choice between two responses may enter into the problem, and we have the origin of the possibility of intelligence. Whitman's description[2] of the reactions of three different species of pigeons, the wild passenger pigeon, the little ring-neck and the common dove-cote pigeon, on finding the eggs gone from the nest shows what a narrow boundary separates instinct from the beginnings of intelligence. The outstanding feature of the deportment of the lower organism is the narrow limits of variation in any given reaction under a given set of conditions.

But narrow limits of variation in a response are not confined to lower vertebrates. New-born mammals usually execute the first few respiratory movements in essentially the same way, using essentially the same motor nerves and muscles as adults. The first swallowing movements are also biologically adequate, resulting in the entrance of food into the stomach.

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[1] See *Columbia University Quarterly*, 1918, XX., pp. 150-152.

[2] *Loc. cit.*, pp. 334-335.

The mechanism for each of these movements is laid down in the sense organs, the afferent nerves, the central nervous system, the efferent or motor nerves and the effectors—the muscles and glands to which they go.

There are two features of this type of movements that are worthy of remark. The first is their high degree of efficiency. In the higher organisms the movements of respiration go on for hour after hour, year after year, always keeping oxygen in the blood and removing carbon dioxide from it as long as life lasts. Few mistakes are made, partly for the reason that the machinery is so highly organized and efficient that mistakes do not often occur, and partly for the reason that when mistakes are made, they are sometimes fatal. The young necturus or the young fish soon leaves the confines of home and shifts for itself. Since its reactions are essentially the same as those of an older fish or an older mud puppy, it catches its food and seeks shelter in the way of all its tribe. And if the young fish does make a mistake, there are plenty more from the same home or other similar homes to make up for the ones that fall into error. Learning, while possible in many of these forms, does not fundamentally change their general behavior. Reactions of this type possess the merit of that form of efficiency which always gets things done in the same unchanging way, and which results from a high degree of organization.

Such efficient and unchanging types of reactions, however, are not without disadvantages. When we compare the movements of respiration and swallowing with the movements of the hand, certain deficiencies of the former type may be brought out. The child can not use its hands in early life with as great precision as it can swallow or breathe. Long periods of instruction and some years of growth are required before it can acquire facility in writing or bricklaying or in using a typewriter or playing a piano. Probably the time never comes when it can do any of these things with as few mistakes as it makes in breathing or swallowing. From this point of view, these reactions never become as efficient as the reactions of breathing or swallowing. And, whereas all that live, breathe and swallow, probably no one individual can learn to write and lay bricks or use the typewriter or play the piano with equal facility. But while these reactions must be learned, and never become as efficient as breathing or swallowing, they offer an avenue of escape from the monotony of the life of the fish and the mud puppy, or the mere occupations of breathing and swallowing. The nervous mechanisms for the control of the movements of the hand are not as highly organized as the mechanism for the control of swallowing and respiration, and arise later in the course of organic evolution. A profound student and philosopher of the nervous system, Hughlings Jackson, called attention to this fact, and remarked that, if all parts of the nervous system were as highly organized as the mechanism for the control of respiration, there would be little hope of the acquisition of new attainments. This statement is worthy of some thought on the part of those who have insisted in recent years that the hope of man lay in a higher degree of organization and efficiency. Nature did not stop with the production of highly efficient nervous systems, but went on to other higher types. And, disconcerting as the discovery may be to the apostles of a high degree of organization, there is scarcely any fact in nature better established than the fact that the evolution of the higher forms has led to the production of a nervous system some of whose mechanisms are not as highly organized as are those of lower animals, but which permit of new attainments by the method of "muddling through" to proficiency if proficiency is ever attained. Man's nervous system permits of muddling through to proficiency in more directions and in more reactions than that of any other animal. And since it is the common observation of many that not all men can muddle through to equal proficiency in all directions, but that one man can do some things better than he can others, we have the existence of those variations which constitute individuality. Following a second line of evidence—that of the course of evolution of the nervous system— we come again to the same conclusion at which we arrived after the survey of the chemical mechanism of coordination—namely, Bergson's statement that life tends toward individuality.

Man manifests individuality in his mental processes quite as much as he does in motor reactions. Often, in fact, his motor reactions follow only as the result of his mental processes. Probably it is more through his individuality in thought rather than of mere action that he has come into conflict, whether for good or evil, with his fellows.

Various means have been adopted in the past in the attempt to limit the exercise of man's individuality through the setting up of conventions of various kinds. Conventions have often been set up to preserve the better things of life and to prevent a falling back to a lower standard. The motive has often been of the highest kind. Other conventions have been set up from motives of self interest to guard the interests and privileges of a small group against the assaults of the multitude. The ultimate effect of conventions of this sort has often been illustrated in the course of human history. The most typical and far-reaching form, so far as its effects on the general intellectual life of the community is concerned, has been the particular sort of convention set up in a theocracy such as that of ancient Egypt or Babylon. The story is best given in the words of a historian.[3]

> In substance, too, the evolution of the two civilizations is strikingly alike. Smaller communities of varied racial origin are slowly welded together under conquering chiefs, whose power is supported by a religious system, also slowly elaborated, in which the divine and human are so closely intertwined that ultimately in each case the ruler and the leading deity are practically identified. In each case a lower and upper kingdom are finally amalgamated round a central city, in the one case Memphis, in the other Babylon, some way removed from the river's mouth. In each case, the priestly order, in close alliance with the throne, devotes itself, in opulence and leisure, to the elaboration of the theological system by a study of the heavens. In each case these observations give valuable material and stimulus to later science, and specially in two spheres of their activity results are achieved of the highest lasting service to mankind. To their beginnings in measurement and calculation we owe most of our common units of time and space, and to their invention of writing probably the foundation of our own. It is these written records which have revealed them to us, and formed to them also one of the strongest links between successive generations. In each case, too, we note in the earliest periods an extraordinary freshness and fineness in their artistic work which is similarly marred later on in both by the extravagances of an imperialistic spirit and the rigidity of convention.

As physiologist, I would be inclined to characterize this kind of convention as an attempt to reduce the action of the neencephalon—the newer part of the brain by which man has attained his individuality—to the level of the relatively unvarying action of the palæencephalon which governs the responses of the fish and the mud puppy and presides over respiration and swallowing, by mere fiat of man. But not all men in the world came under the dominance of Egypt or Babylon, and the Egyptian and Babylonian empires did not last forever. Other men in other parts of the world were unbound by convention of this sort and man's progress continued for a time in more favorable surroundings.

Greece was the next place in which the light of man's intellect flamed up and we read in such a work as Professor Bury's "History of the Freedom of Thought"—a work worthy of being read by every student of science—that reason was free in Greece and Rome. Yet convention did not wholly pass them by. And again in Greece the origin of the convention can be traced to the desire of a small group to protect their own interests or to conserve their own source of revenue.

[3] Marvin, "The Living Past," pp. 32–33.

The priestcraft of the earliest times met with difficulties in gaining the ascendancy and in maintaining it when it was once obtained. Perhaps the clearest picture of the nature of these difficulties and of the attempt to overcome them by building up a system of convention for mostly sordid motives is to be found in the history of Greece. Homer, as A. W. Benn[4] remarks, treated the gods in a humorous, joking sort of a way which no organized priestcraft would have permitted. But at that time no organized priestcraft existed, and a certain sceptical attitude did no particular harm. But, as soon as a priestcraft began to develop, the need for funds arose. No priestly hierarchy could get money from the populace so long as it had back of it only the sort of gods Homer described. And since traducers of the gods interfered with the general scheme of financing the priestcraft, such traducers had to be dealt with. Since the opportunity for casting aspersions on the gods ended with the life of the irreverent individual, it seemed a simple solution of the problem to kill the irreverent individual. This was attempted in the case of Anaxagoras, who held unorthodox views concerning the nature of the sun and moon.[5] It seems probable that Anaxagoras escaped death for blasphemy, and the system never worked out as well at Athens as it did in other countries in later years. But it was soon found that the death of one individual did not wholly solve the problem, and it became necessary to make the attack on it in a systematic way. Legal sanction for the execution of heretics and blasphemers was obtained, and the power of the priestcraft increased. Everything seemed to be going well.

As time went by, however, some began to suspect that the method of the priestcraft was not, after all, the best method of approaching the solution of the problem. To some, it seemed best to eliminate gods of questionable character and get along with those of known worth. Scourging the money-changers from the temple is one concrete instance of the application of this method applied to more mundane affairs. This latter method of approach did not, however, meet with universal favor, especially in official quarters, and it was only after the lapse of generations that the Greek gods and others of their ilk were eliminated. The two methods persist to-day, and usually the weight of official opinion has been thrown in on the side of the first method. In general, mankind has been divided into two great groups, one of which has been engaged in "putting things over" and the other composed of those who have been told that it is impolite, or even impolitic, to make a fuss.

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[4] "Early Greek Philosophy," p. 7, New York.

[5] Benn, *loc. cit.*, p. 75.

The two groups have sometimes, but not always, been divided on the basis of age. A quotation from the work of a student of Greek drama is in point here.[6] Sheppard, in speaking of the age of Euripides, remarks concerning affairs at Athens:

> Superstition still prevailed. Therefore the Enlightenment was salutary, and was necessarily disruptive. It was also inevitable. When the fathers think the Age of Reason is achieved, the sons may be trusted, if they are of good stock, to see that it is still far off. The revolution in thought, which Aristophanes deplored, was the legitimate offspring of the Periclean age, though, like most children, it scandalised its parent. From the time when Pericles became supreme, Athens was the center of Greece. Her citizens travelled, and saw the customs of many nations. In the assembly, and the law-courts they needed the arts of rhetoric, even before teachers came from Sicily to teach the argument. All men who had ideas found listeners and ready talkers in Athenian gymnasia, and the seeds of opinion ripened after the sowers had perhaps been sent about their business. Everything, divine and human, had to stand the test of criticism.

Much the same idea is expressed by James Russell Lowell in his "Ode for the Fourth of July, 1876":

> Poets, as their heads grow gray,
> Look from too far behind the eyes,
> Too long experienced to be wise
> In guileless youth's diviner way.

The blindness to the ways of youth is still with us. Free in thought though we may boast ourselves to be, there are yet few among the elders who have remained sufficiently free from convention to regard "guileless youth's diviner way" in its true light. For it, too, is a result of evolution, and upon its continuance our progress depends.

The problem of the autocratic ruler has not been very different from that of the priestcraft, and the method of attempted solution has been very much the same. There grew up in "that Divinity that doth hedge a king" an elaborate system of convention which tended to limit the expression of the individuality on the part of the subjects of the kingdom. The most elaborate survival of such a form of convention is the taboo of the South Sea Islands, since it could scarcely survive in any society in which the elaborate claims of the ruler were subjected to any sort of critical inquiry. Conventions of this sort flourish best among peoples whose general mental processes are not characterized by any high degree of individuality. But facts and theories of this nature fall in the province of the social anthropologist, and his opinion is entitled to a hearing. Both physiologist and anthropologist have little hesitancy in regarding the taboo as superstition. Going on from this point, the social anthropologist recognizes that without the aid of superstition to maintain them, some of our common political and social institutions would have been modified or have collapsed long ago. The institutions of government, of private property, of marriage and even of respect for human life were originally founded upon superstition, and maintained by it long after their foundation.[7] Superstition has not been without its beneficial results, since some of these institutions have been worthy of preservation. But one may hope that eventually all of these institutions will be placed on a rational basis and worked out in accordance with the principles of human reason.

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[6] Sheppard, "Greek Tragedy," p. 124.

THE JUSTIFICATION OF THE FREEDOM OF THOUGHT

The conventions set up by the ancient priestcraft and the kings of the ancient monarchies tended to limit the freedom of thought. Other conventions have tended toward the same end, and man has, sooner or later, rebelled against them. Bloodshed has been the price paid for breaking convention and securing freedom of thought. Much discussion has centered about the question, and discussion is likely to continue for some time to come. As a biologist, I would consider that the question of freedom of thought is bound up with man's nervous system. The historian finds a justification for the freedom of thought, not "on the conception of natural right," but "on the assumption that the progress of the race, its intellectual and moral development is a reality and is valuable."[8] Biology comes to the aid of this assumption; and, from the point of view of organic evolution, it is not so much an assumption as a fact. Mental processes, as Burdon-Sanderson stated,[9] are a part of the specific energies of the organism, and should, on that ground, be included in the subject-matter of physiology. Referring back to the point of view of the physiologist, we may suppose that, ordinarily, mental processes go on for the good of the individual. A man's thoughts become a part of the general activity of his nervous system, and can not be unreasonably limited without interfering with his internal development, which has arisen, and, let us hope, will continue, as the result of processes of organic evolution. As Herbert Spencer expresses it, "a man's thoughts are as children born unto him, which he may not willingly let die." But mental processes, like other processes in the body, may become perverted, and we may have mental disease as a result. Such diseased persons must be treated as diseased persons and not as persons possessed of a devil. But if it be true, as I think is undoubtedly the case, that "the progress of the race, its intellectual and moral development" is a product of, or has arisen in the course of, organic evolution, the whole object and end of evolution has not been the development of ferocity. This conclusion is not wholly new. Huxley, years ago, remarked that man, having attained to his present state, would be glad to see the ape and the tiger die, but they refused to suit his convenience. But, new or old, the conclusion needs more emphasis than it has received in the last five years or more. Good animals are necessary, but good men are still more necessary if the race is to distinguish itself from other animals by properties other than mere anatomy. The Greeks recognized this; for Sophocles, in his chorus of Antigone, made this statement:

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[7] Frazer, J. G., "Psyche's Task," London, 1913.

[8] Bury, *loc. cit.*, pp. 240–241.

[9] *Loc. cit.*, p. 469.

> Of all strong things none is more wonderfully strong than Man. He can cross the wintry sea, and year by year compels with his plough the unwearied strength of Earth, the oldest of the immortal gods. He seizes for his prey the aery birds and teeming fishes, and with his wit has tamed the mountain-ranging beasts, the longmaned horses and the tireless bull. Language is his, and wind-swift thought and city-founding mind; and he has learnt to shelter him from cold and piercing rain; and has devices to meet every ill, but Death alone. Even for desperate sickness he has a cure, and with his boundless skill he moves on, sometimes to evil, but then again to good.

The Greeks, however, were remarkably free from superstition, considering the age in which they lived. The "city founding mind" does not reach its fullest opportunities until it has cleared away superstition. For one in peril of his soul does not think freely or accurately on all matters which pertain to him. Some of the agents which man has used in clearing away superstition may now be mentioned.

THE PLACE OF BIOLOGY IN THE LIFE OF A NATION

Century after century man has been struggling to break down convention and obtain opportunity for the expression of his individuality. Often he has been defeated in the struggle and the progress of the world has halted for a time, or a particular nation has fallen into stagnation. But each time, somewhere in the world, man, driven by the forces within him, has sooner or later broken through the particular system of convention which aroused his anger. Man's reaction against convention may be viewed as a biological reaction. Man has attempted to provide an environment, social and political, which permits the expression of individuality and which is worthy of man. Science has had its part in the struggle, and on the whole, it has been a worthy part. A brief statement of the place of science in the life of a people may be given here.

In the long run, the material advancement of the world has rested upon mathematics and the physical sciences generally, and the freedom of human thought from superstition, upon the natural and biological sciences. Not a railway is constructed, nor a great building erected, nor an ocean liner launched without previous mathematical calculation. The fundamental importance of all branches of mathematics for all branches of engineering is so well known as to need no further comment.

It is not so generally recognized, however, that man's freedom from superstition has come about through the development of the natural and biological sciences. But mothers in civilized countries no longer cast their children into the fiery image of Moloch to appease the gods who sent the plague in their wrath. We kill the plague-bearing rats and drain the swamps where the disease-bearing mosquitoes breed. Yet superstition lingers in the popular mind as an evidence that the task of biology is still unfinished. But on one point, biology has a clear, definite and unequivocal statement to make, and that is, no ruler holds his throne by divine right. The wisdom of all the doctors can not convince us to the contrary. If it is seriously believed in any country that autocratic rulers have any special prerogatives denied by the gods to ordinary mortals, it is a reflection upon the state of biology in that country. Nor is the biologist inclined to regard with much favor the claim of a people or nation to divine guidance in a greater measure than is granted to their neighbors. Much bloodshed might have been avoided if it had been clearly recognized that all claims of this sort rest upon superstition and not upon any rational foundation. From past experience one might predict what the reaction of man would be to any attempt to interfere unreasonably with the exercise or expression of his individuality. We may, then, look a little more closely into the elements that aroused a man's anger at the outbreak of the war.

(To be concluded)